Original Article

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# Utility of a portable ultrasound diagnostic imaging device to evaluate pregnancy-related mammary gland development

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**Abstract**

**Purpose:** This study was performed to examine the utility of a portable ultrasound diagnostic imaging device to evaluate mammary gland development over the course of pregnancy.

**Methods:** Eight women with normal pregnancies participated in the study. The portable ultrasound diagnostic imaging device used was a Vscan Dual Probe (GE Healthcare, Tokyo, Japan). For the measurement area, the probe was placed at the 10:30 position in C area of the right breast, with the edge of the probe at a position corresponding to the edge of the nipple. The subjects lay in the supine position with adjustment using a towel so that the breast was in a natural shape. Mammary gland thickness and imaging appearances were assessed longitudinally three times (once in each of the first, second, and third trimesters of pregnancy).

**Results:** Mammary gland thickness increased over the course of pregnancy in all subjects. The mammary gland thickness showed a significant increase in the second and third trimesters of pregnancy compared to the first trimester ($p < 0.01$). In five of eight subjects (62.5%), we found changes in imaging findings associated with the progress of pregnancy. From the first through the second trimester, the mammary glands became hypoechoic, and the subcutaneous fat thinned. Imaging findings were not uniform and showed variations between subjects.

**Discussion:** This study suggested that the portable ultrasound diagnostic imaging device is useful for evaluation of mammary gland development associated with the progress of pregnancy based on mammary gland thickness. However, it is difficult to evaluate mammary gland development by imaging findings. It is preferable to use changes, such as “the mammary glands became hypoechoic” and “the subcutaneous fat thinned,” as references for evaluating mammary development.

**KEY WORDS**

pregnant women, pregnancy, mammary gland, portable ultrasound diagnostic imaging devices, breastfeeding

## Introduction

Breastfeeding offers great benefits for both mother and child and is being promoted worldwide by the World Health Organization and UNICEF. Successful breastfeeding requires the ability to produce and secrete milk by the breasts, as well as the induction of effective milk ejection by the infant’s suckling after birth[1-2)]. For the latter, breastfeeding has become proactively supported with the evidence-based ‘10 steps to successful breastfeeding’ proposed by WHO/UNICEF. However, despite appropriate support, it has been reported that 5-6% of mothers exhibit lactation deficiency, one cause of which is mammary gland hypogenesis[3)].

The breasts consist of mammary tissue and adipose tissue supported by connective tissue called Cooper’s ligaments, and the mammary tissue has the ability to produce and secrete milk[2, 4)]. Each mammary gland is composed of 15 to 20 glandular lobes, which consist of

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lobules containing acini, the smallest functional unit of the breast. Each glandular lobe has milk ducts, which carries the milk produce in the lobules to the nipples[4-6]. The function of the mammary glands peaks during lactation, whereby pregnancy promotes mammary gland development as a result of changes in various hormones such as estrogen and progesterone secretion[7, 8]. During the first trimester, remarkable lobule – acini growth is seen, the number and size of acini increases, and the ductal system extends and develops branches[9-11]. Mammary fat decreases with the proliferation of epithelial cells[8, 9]. During the second trimester, acini growth is promoted even further[11]. Moreover, colostrum appears in the acini and milk ducts, and increases throughout the third trimester[4]. Although branching of the ductal system continues in the third trimester, it is not as remarkable as in the first trimester[9]. An earlier study observing the mammary glands during pregnancy using an ultrasound diagnostic imaging device to examine the relationship with postpartum lactation suggested that mammary gland development during pregnancy differs in each individual, and that lactation differs depending on the state of mammary gland development[12-15]. To predict postpartum lactation from during pregnancy to help with breastfeeding support, we think that the development of the mammary glands during pregnancy should be evaluated. However, mammary gland development does not differ according to the form or size of the breasts, or birth history[4, 13, 16], and it is difficult to objectively evaluate the development of the mammary gland only by palpation and visual examination used in conventional clinical practice.

The use of ultrasound diagnostic imaging devices has recently gained widespread popularity in the diagnosis of mammary gland disease. As it is noninvasive and causes no impact on the fetus such as radiation exposure, it is suitable for breast examination during pregnancy[17]. While there have been some cases of nurses examining the mammary glands to screen pregnant women for mammary gland disease[18], there have been almost no cases in which the device is used to observe normal mammary gland development during pregnancy. To date, observation of the mammary gland during pregnancy by ultrasound has been useful in predicting lactation[12-15], but this method is not yet widely used. One possible reason is that it is too inconvenient for nurses to use the method routinely. In the perinatal department, ultrasound is widely used for the evaluation and screening of fetal development and it is a general testing device. However, the stationary ultrasound that is generally used is not easy to carry, and has temporal and spatial limitations for usage.

Therefore, we assessed the usefulness of portable ultrasound diagnostic imaging devices (hereinafter “pocket ultrasonography”). Pocket ultrasonography is the smallest and lightest device and can be carried in a white coat pocket[19]. It has the benefit of allowing simple, noninvasive, bedside observation. The application of pocket ultrasonography by midwives and nurses to verify the fetal heart rate and fetal position has already been reported[20]. Therefore, if observation of mammary gland development were possible, then we can expect that the range of pocket ultrasonography application will increase further. However, it is unknown whether pocket ultrasonography can be used to evaluate the development of mammary gland with the progression of pregnancy because it is inferior in performance with respect to the sharpness of image as compared to that of the stationary ultrasound. It is said that mammary gland development associated with pregnancy involves changes that can be observed by ultrasonographic imaging including ‘increased mammary gland thickness’, ‘hypoechoic signal in the area of mammary gland development’, and ‘reduction (thinning) of subcutaneous fat tissue’ [21, 22, 23]. To evaluate mammary gland development associated with the progress of pregnancy, it appears necessary to be able to observe these changes by pocket ultrasonography. The aim of this study was to examine the utility of pocket ultrasonography in evaluating mammary gland development over the course of pregnancy.

## Methods

### 1. Subjects

The subjects were pregnant women with normal pregnancies. Women with a history of breast lesions or surgery, who had underlying diseases, or who were still breastfeeding at the time of the study were excluded.

Each subject was examined a total of 3 times, once each in the first trimester (between confirmation of a fetal heartbeat and the 15$^{th}$ week of pregnancy), second trimester (between the 22$^{nd}$ and 26$^{th}$ weeks of pregnancy), and third trimester (after the 36th week of pregnancy).

2. Study Period

From December 2015 to December 2016.

3. Device Used

The pocket ultrasonography was the Vscan with Dual Probe (GE Healthcare, Tokyo, Japan) (Figure 1). This pocket ultrasonography device is equipped with a linear probe of 8.0 MHz, which is the maximum frequency capable of observing superficial soft tissue. While this does not meet the frequency of 10 MHz recommended for breast ultrasonography in the guidelines for breast ultrasound diagnosis[21, 22], a frequency of 7.5 MHz or above is considered suitable for the observation of the mammary glands[23]. In an earlier study that examined the mammary glands of pregnant and puerperant women [12-15, 24-26] using an ultrasound diagnostic imaging device with a frequency of 7 − 10 MHz, all mammary glands could be identified. Therefore, in the present study, the pocket ultrasonography used was considered suitable for observation of the mammary glands. Furthermore, the probe of pocket ultrasonography used in the present study was a two-in-one probe, i.e. it was equipped with two types of probes, a linear probe and sector probe. The fact that the probe can be utilized without replacing the sector probe used in routine practice by the perinatal division was considered convenient and easy to adapt in clinical practice. This pocket ultrasonography was compact with 436 g in weight and 3.5 inch in screen size. Furthermore, it was easy to carry because it is operated with rechargeable battery.


Figure 1. The portable ultrasound diagnostic imaging device used in this study
The body of this pocket ultrasonography is foldable and palm-sized. Linear and sector probes are mounted on each end of the probe.

4. Measurement Method

For the measurement area, the probe was placed at the 10:30 position in C area of the right breast, with the edge of the probe positioned to correspond to the edge of the nipple (Figure 2). To minimize the subject's discomfort associated with long measurement time, only one point was measured to enable shorter observation time in this study. In the clinical practice guidelines for breast cancer (The Japanese Breast Cancer Society), C area corresponds to the lateral upper area of the breast, and consists of a higher distribution of subcutaneous tissue including mammary glands compared to in other areas. Thus, in this area, it is considered easier

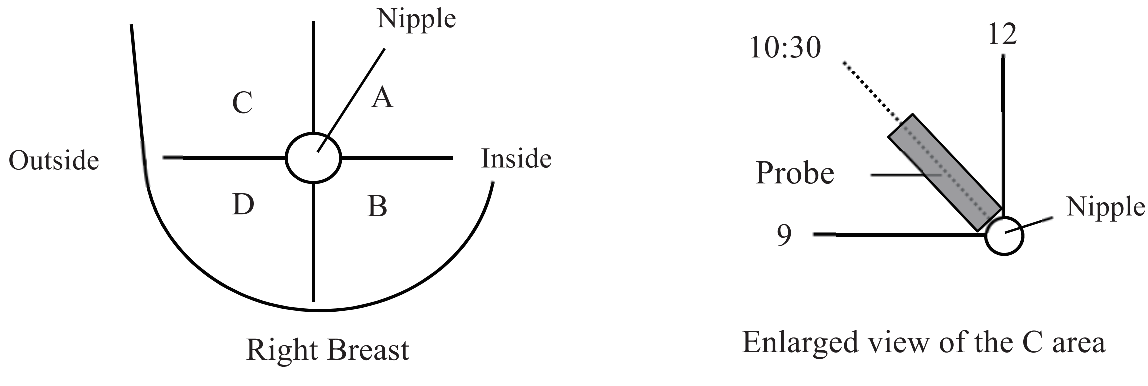
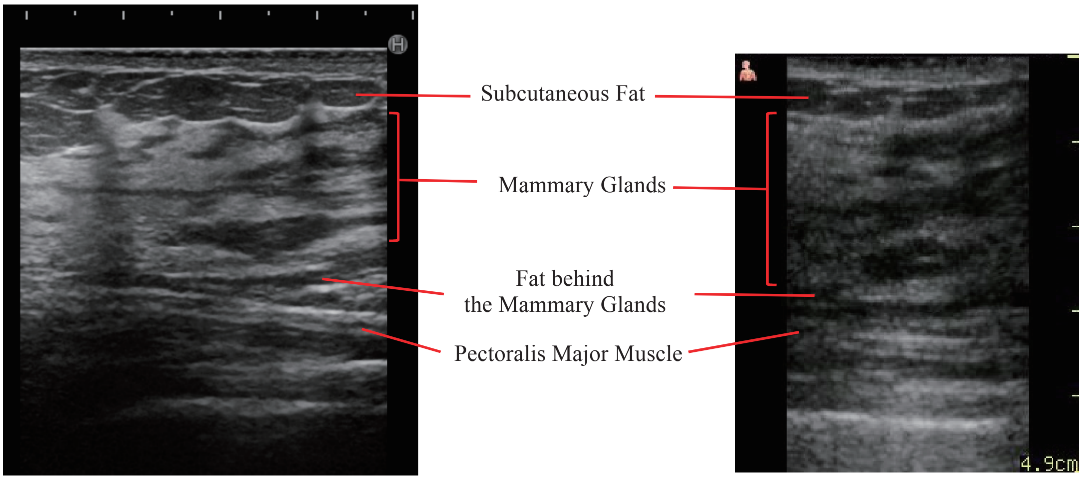



Figure 2. Position of the probe when observing the mammary gland
The left figure shows the division of the right breast based on the breast cancer handling regulations (Japanese Breast Cancer Society). Among these divisions, the enlarged view of the C area is shown on the right figure. When the breast was regarded as a clock board, the probe was put on the part corresponding to 10:30.




High-performance Ultrasound Image
(Nobulus : Hitachi-Aloka Medical)

Pocket Ultrasound Image
(Vscan Dual Probe: GE Healthcare)

Figure 3. Comparison of pocket ultrasound image and high-performance ultrasound image in the breast
These images were taken of the region of 10:30 in the C area of the right breast of the same subject (20s, woman who was not pregnant).

to observe inside of the breast by ultrasonography[13]. Therefore, we thought that this was suitable as the imaging site.

The imaging procedure was performed in accordance with the guidelines for breast ultrasound diagnosis[22]. Subjects rested in the supine position with a towel inserted under the right side of their back so that their torso was tilted naturally, and their breasts rested evenly over the rib cage. Upon training in the measurement technique, researchers received guidance from a mammary gland specialist. In order to ensure unity of measurements, one researcher performed all study measurements.

### 5. Comparison of Image Findings Obtained by High-powered Ultrasonography and Pocket Ultrasonography

On ultrasonic images of the breasts, subcutaneous fat, mammary glands, fat behind the mammary glands, and the pectoralis major muscle need to be delineated[21, 27]. Prior to performing the present study, to determine whether or not each of these sites could be identified by pocket ultrasonography, we compared findings with those from a high-powered ultrasound imaging diagnostic device (Nobulus : Hitachi-Aloka Medical), which has a linear probe with maximum frequency of 18MHz. The subject sample comprised six healthy adult women who were not pregnant, and one primipara in the second trimester, in whom C area of each breast was observed at the 10:30 position both by pocket ultrasonography and the high-powered ultrasound diagnostic imaging device, respectively. Results indicated that in all subjects, pocket ultrasonography image sharpness was inferior. However, even with pocket ultrasonography, each site was able to be accurately identified as per the high-powered ultrasound diagnostic imaging device (Figure 3).

### 6. Items Observed

#### 1) Mammary Gland Thickness (mm)

On ultrasound images, the mammary glands are more hyperechoic than the subcutaneous fat, with scattered hypoechoic areas appearing like leopard spots (speckled)[21]. Directly beneath the subcutaneous fat, appearing as a linear hyperechoic area located between the pectoralis major muscle, the site showing the aforementioned image findings was identified as the site occupied by the mammary glands.

As the site occupied by the mammary glands generally becomes thinner towards the lateral side of the breast extending from directly beneath the nipple because of the breast morphology, the mammary gland thickness differs depending on the site. In this study, the measurement site was fixed so that changes over time could be observed, and the mean thickness of the mammary glands was calculated from the measurement of three points including both edges and the center of ultrasound images. Taking errors into consideration, measurements were taken three times using the same procedure, and the mean value was defined as the mammary gland thickness. After inputting the images into a PC, the mammary gland thickness was measured using the measurement tool of image data management software "Vscan gateway software" for Vscan Dual Probe (GE Healthcare, Japan).

### 2) Imaging Findings

Ultrasound images of each pregnancy trimester were macroscopically compared for each subject, and changes in image findings associated with the progress of pregnancy were observed. We particularly focused on whether we could see findings that were considered to be changes caused by pregnancy in the guidelines[21,22] such as 'the mammary glands taking on a relatively homogenous hypoechoic appearance', and 'subcutaneous fat decreasing (becoming inconspicuous)'.

### 7. Validity and Reliability of Mammary Gland Observation by Pocket Ultrasonography

In six healthy adult women who were not pregnant, C area of each breast was observed at the 10:30 position both by pocket ultrasonography and the high-powered ultrasound diagnostic imaging device, and the thickness of the mammary gland was measured. Calculation of the correlation coefficient for the mammary gland thickness measured by pocket ultrasonography and the high-powered ultrasound diagnostic imaging device revealed $r = 0.85$ ($p < 0.001$), and criterion-related validity was confirmed. A mammary gland specialist verified whether or not each site including the mammary glands were properly identified from the ultrasound images.

With the same six adult women noted above, the researcher, and the other researchers who had undergone training in the ultrasonic measurement of the mammary glands observed the mammary glands of each subject by pocket ultrasonography, and measured the mammary gland thickness. Calculation of the inter-rater reliability coefficient from the mammary gland thickness measured by two individuals revealed ICC = 0.96 ($p < 0.001$).

### 8. Analysis

Statistical analyses were performed using SPSS statistics ver.24 for Windows. A one-way analysis of variance and Bonferroni multiple comparisons were used to compare the mammary gland thickness for each pregnancy trimester. The significance level was defined as being below 0.05 for all analyses.

### 9. Ethical Considerations

This study was approved by the Kanazawa University Medical Ethics Committee (approval number: 587-1). Considering that the study was potentially embarrassing, the subjects were first provided written and verbal explanations and assurances that participation was entirely voluntary. An effort was also made to minimize breast exposure. Also, data was strictly managed by securing anonymity.

## Results

### 1. Characteristics of Subjects

Of the 20 subjects recruited, we excluded 5 subjects who did not provide consent, and 7 subjects who were unable to be followed up due to reasons of deviation from a normal pregnancy progress, and hospital transfer to a distant area. Thus, 8 subjects were ultimately included in our analyses.

The subjects were 2 primiparous and 6 multiparous women. The mean age was 33.5 ± 3.1 years (mean ± the standard deviation [SD]), mean height was 159.6 ± 5.2cm, mean body mass index before pregnancy was 20.3 ± 1.5, and mean weight gain during pregnancy was 10.30 ± 3.0kg. The 6 multiparous women had all breastfed their first child.

### 2. Changes in Mammary Gland Thickness over the Course of Pregnancy

At all subjects and all trimesters of pregnancy, it was possible to identify the space occupied by the mammary gland from ultrasound images and to measure the thickness of the mammary gland. Mammary gland thickness was 22.9 ± 6.7 mm (mean ± SD) in the first trimester, 30.9 ± 7.0 mm in the second trimester, and 32.2 ± 7.3 mm in the third trimester. Paired one-way analysis of variance indicated significant differences in the thickness of the mammary glands during each pregnancy trimester ($p < 0.001$). Multiple analysis revealed a significant difference between the first and second trimesters, as well as the first and third trimesters ($p < 0.01$), with the thickness of the mammary glands having significantly increased in the second and third trimesters (Figure 4). While the thickness of the mammary glands tended to increase from the second trimester throughout the third trimester, no significant difference was observed ($p = 0.815$).

Upon examining changes in the thickness of the

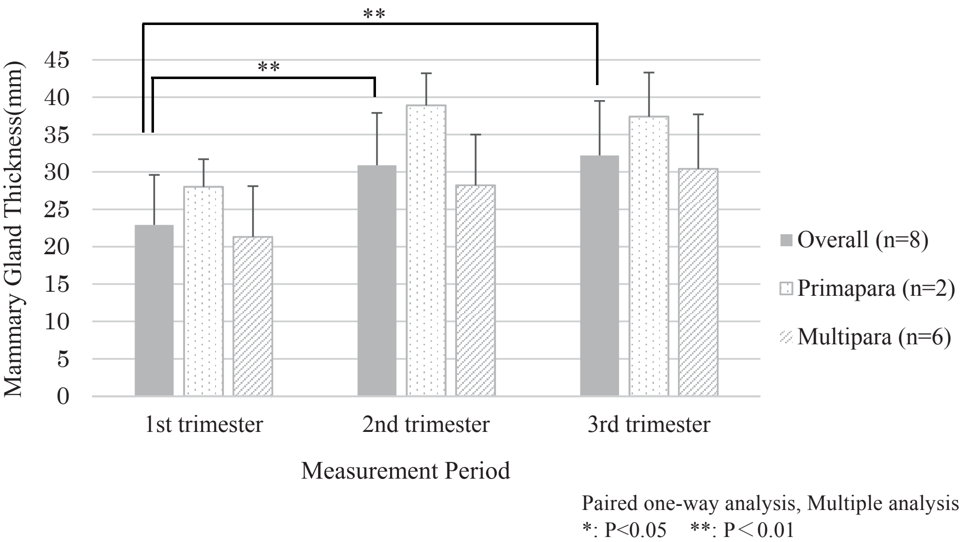



Figure 4. Change in mammary gland thickness over the course of pregnancy

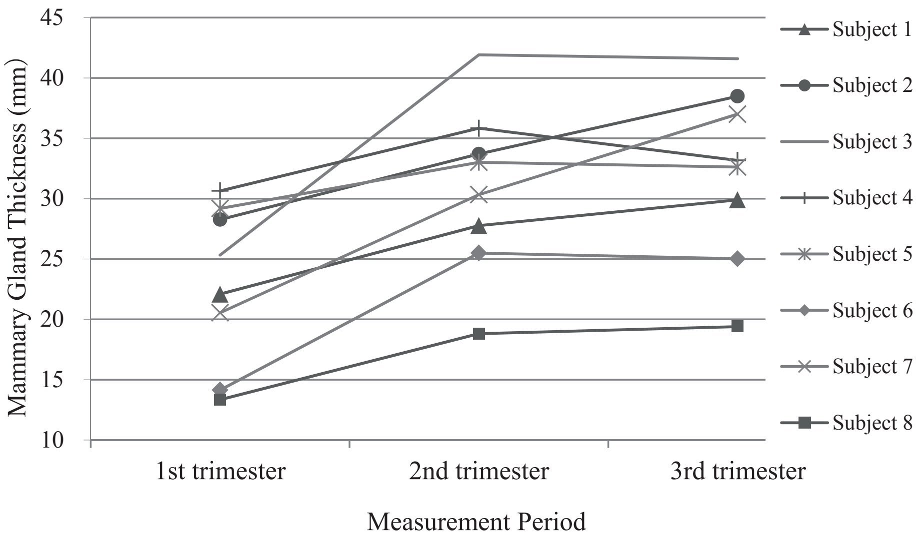



Figure5. Mammary gland thickness over the course of each subject's pregnancy

mammary glands according to birth history, it was found that the thickness of the mammary glands of primapara was 28.0 ± 3.7 mm in the first trimester, 38.9 ± 4.3 mm in the second trimester, and 37.4 ± 5.9 mm in the third trimester. The thickness of the mammary glands multipara was 21.3 ± 6.8 mm in the first trimester, 28.2 ± 6.8 mm in the second trimester, and 30.4 ± 7.3 mm in the third trimester. For both the primapara and multipara women, the thickness of the mammary glands increased with the progress of pregnancy, and in particular, the thickness tended to increase from the first trimester throughout the second trimester (Figure 4).

Evaluation of changes in each of the 8 subjects revealed that the mammary glands grew in some subjects (subject3, 4, 5, 6, 8) primarily from the first to second trimesters and remained mostly unchanged from the second to third trimesters, whereas in other subjects (subject1, 2, 7), the gland thickness increased throughout all 3 trimesters (Figure 5).

**3. Changes in Imaging Findings over the Course of Pregnancy**

In the first trimester, the mammary glands of all subjects appeared speckled including a hypoechoic area. However, the image findings were not consistent but

Table1. Presence or absence of changes in imaging findings over the course of each subject's pregnancy

| | Mammary glands became hypoechoic | | Subcutaneous fat thinned | |
|---|---|---|---|---|
| Subject | 2nd trimester | 3rd trimester | 2nd trimester | 3rd trimester |
| 1 | × | ○ | × | × |
| 2 | ○ | × | ○ | × |
| 3 | × | × | × | × |
| 4 | × | × | × | × |
| 5 | × | × | × | × |
| 6 | × | × | × | ○ |
| 7 | ○ | × | × | × |
| 8 | ○ | × | × | ○ |

*Note.* It shows the presence or absence of change when compared with the image of the previous measurement period. ○: With change in findings, ×:No change in findings.

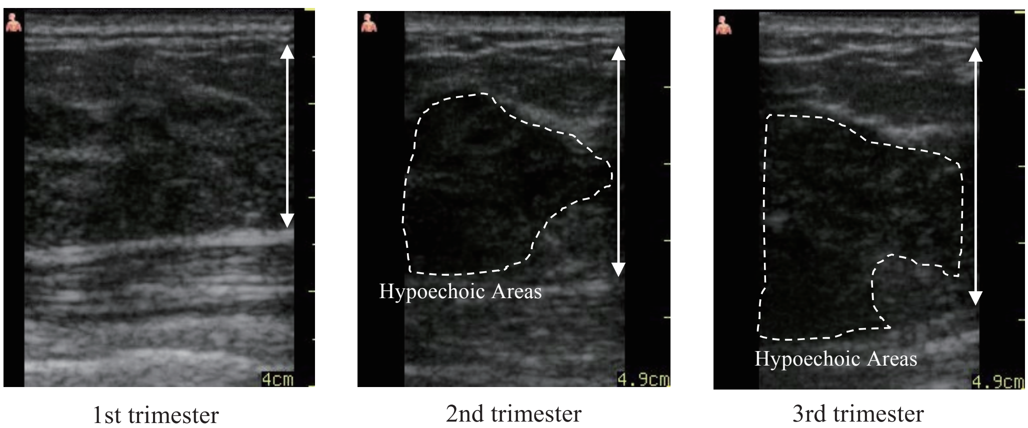



Figure 6. Pocket ultrasound images of the subject 7 (30s, multipara) who was easy to observe the change in image finding that the mammary gland becomes hypoechoic
The area occupied by the mammary gland is indicated by arrows. In the 1st trimester, there are many areas that look white (hyperechoic area) overall. In the 2nd and 3ird trimester, particularly in the middle of the image, black areas (hypoechoic areas) is conspicuous.

differed depending on the subject. Upon macroscopically comparing the image findings of each subject, in 5 out of 8 subjects (62.5%) we found changes in image findings associated with the progress of pregnancy (Table 1). The image findings for both the mammary glands and fat tissue that exhibited changes are shown.

### 1) Mammary Gland

Compared to the first trimester, in the second and third trimesters, 4 out of 5 subjects showed 'an increase in hypoechoic area in the mammary glands', and 'the mammary glands took on a relatively homogenous hypoechoic appearance'. This change was perceived from image findings of the first through to the second trimester. From the second through to the third trimester, no major macroscopic differences were observed. The shift in ultrasound images of one case (subject 7, multipara in 30s) with marked changes is presented in figure 6. In the first trimester, the mammary glands appeared speckled with hypoechoic areas dispersed within a hyperechoic area. However, the mammary glands appeared more hypoechoic in the second trimester compared to the first trimester. Compared to the first trimester, the speckled range had reduced, and the image was relatively evenly hypoechoic. The changes were particularly remarkable extending from near the middle of the image towards the site of the pectoralis major muscle (Figure 6).


Figure 7. Pocket ultrasound images of the subject 2 (30s, multipara) who was easy to observe the change in image finding that the subcutaneous fat becomes thin
In the 1st trimester image, the range of subcutaneous fat observed as hypoechoic areas is indicated by an arrow. In the 2nd and 3rd trimester, hyperechoic area occupies the upper area of the image and it is difficult to observe subcutaneous fat, so it is considered that subcutaneous fat became thin.

### 2) Fat Tissue

In 3 out of 5 subjects, 'thinning of the subcutaneous fat' was perceived. The shift in ultrasound images of one case (subject 2) with marked changes is presented in Figure 7. In the first trimester, the subcutaneous fat seen as a hypoechoic area between the skin and mammary glands macroscopically was a certain thickness, but the thickness became thinner in the second trimester. Furthermore, in the third trimester, the majority of the area between the skin and the pectoralis major muscle appeared as hypoechoic areas dispersed within a hyperechoic area. That is, the mammary glands occupied an extensive area, and the subcutaneous fat became less obvious (Figure 7).

In the first trimester, subjects with thin unremarkable subcutaneous fat showed no macroscopic change in subcutaneous fat throughout the pregnancy. Furthermore, the fat behind the mammary gland between the mammary gland tissue and the pectoralis major muscle were unclear and difficult to observe in most subjects.

## Discussion

The utility of pocket ultrasonography in the evaluation of mammary gland development associated with the progress of pregnancy was examined in the present study from the perspective of the thickness of the mammary gland and ultrasound image findings.

### 1. Evaluation of Development according to Mammary Gland Thickness

We found that the thickness of the mammary glands increased with the progress of pregnancy. In particular, the thickness significantly increased from the first trimester through the second trimester, and while the thickness tended to increase from the second trimester through the third trimester, there was no significant difference. This result is consistent with the report by Watanabe et al[15]. who longitudinally observed the thickness of the mammary glands from the first trimester through the third trimester using an ultrasound diagnostic imaging device. The increase in the thickness of the mammary glands on ultrasound images is attributed to the development of acini and the ductal system[21], and the quantitative development of acini and the ductal system is most remarkable in the first trimester[7]. Although development continues to be promoted from the second trimester onwards, it is not as remarkable as in the first trimester[10, 11]. The shift in the thickness of the mammary glands associated with the progress of pregnancy observed in the present study tended to correspond to these characteristic developments of the mammary glands, and therefore it was suggested that pocket ultrasonography is useful for the evaluation of mammary gland development associated with the progress of pregnancy on the basis of mammary gland thickness. In the first trimester, there were already individual differences observed in the thickness of the mammary glands. However, all subjects showed an increase in the thickness of the mammary glands associated with the progress of pregnancy. While there are individual differences in the thickness of the mammary glands[5], there are no reports of the use of mammary gland thickness as an indicator for good mammary gland development. Kasai et al. reported that there is no correlation between the transient mammary gland thickness and the amount of milk secreted after delivery, and that pregnant women with thin mammary glands during pregnancy have good milk secretion[14]. Therefore, it appears difficult to identify the standard unconditional mammary gland thickness indicating good and poor mammary gland development. For the evaluation of development, we think that it is preferable to do so on the basis of individual changes in mammary gland thickness associated with the progress of pregnancy.

Upon examination of shifts in the thickness of the mammary glands according to each subject, some subjects showed an increase in thickness from the first trimester through the second trimester, and some subjects showed an increase in thickness from the first trimester through the third trimester. It has been reported that while the breasts change for most women up to around week 22 of pregnancy, some women show very little change, and some women show changed throughout the entire pregnancy[4]. As blood concentrations of progesterone and estrogen, which promote mammary gland development increase up to delivery[11], mammary gland development might be promoted up to the third trimester. Haku et al. conducted a longitudinal study of the thickness of the mammary glands in pregnant women, and as a result, they found a pattern in mammary gland development. When the subject sample was divided into those with mammary gland development until 15 weeks of pregnancy, and those with mammary gland development from the second trimester through the third trimester, they reported that individuals with mammary gland development up to 15 weeks of pregnancy had a higher rate of breastfeeding postpartum[12]. In the present study also, the fact that the shift in mammary gland thickness was not uniform but differed according to the subject was as per findings of earlier studies, and therefore pocket ultrasonography helps determine characteristic shifts in mammary gland thickness of subjects, and measure postpartum milk secretion. Our small subject sample in the present study meant that we were unable to examine the relationship with postpartum milk secretion. Thus, examining evaluation methods of mammary gland development by pocket ultrasonography by way of investigating the relationship between shifts in mammary gland thickness and milk secretion is a task to address in future.

### 2. Evaluation of Development by Ultrasound Image Findings

Changes in image findings perceived in the present study were that, from the first trimester through the second trimester, the mammary glands became hypoechoic, and the subcutaneous fat thinned. The area of mammary gland development, that is the area with growth of acini and the ductal system, is said to appear hypoechoic on ultrasound image findings[21, 22]. In the present study, the mammary glands became hypoechoic from the first trimester through the second trimester, which we think to be a result indicating observation of the area of acini and ductal system growth. Changes were seen during the period from the first trimester through the second trimester, which is consistent with the characteristic marked development in acini and the ductal system generally in the first trimester[7]. However, regardless that the mammary gland thickness increased in all subjects, the hypoechoic change in the mammary glands was not found in all subjects. It is said that mammary gland development begins from around 5 to 8 weeks of pregnancy[7]. In the first trimester, the mammary glands appeared as speckled images including hypoechoic areas in all subjects. Therefore, mammary gland development had already commenced by the time of the first trimester examination. We consider that the area of acini and ductal system growth could have appeared hypoechoic. We also consider that limitations to the sharpness of pocket ultrasonography images made it difficult to perceive changes in image findings.

It is said that the thinning of subcutaneous fat reflects the decrease in adipose tissue as the growth of acini and the ductal system progresses[8, 9]. However, the volume of adipose tissue in the breasts differs according to the body fat percentage of the individual[21], and subcutaneous fat, as well as fat behind the mammary glands may not be observed depending on the individual. In this study also, subjects with thin, unremarkable subcutaneous fat in the first trimester showed no change macroscopically in subcutaneous fat throughout the pregnancy. Therefore, in the event of subjects in whom subcutaneous fat can be observed in the first trimester, it appears to be easy to perceive thinning of subcutaneous fat associated with the development of the mammary glands.

On the basis of the above, it cannot be said that the evaluation of mammary gland development according to image findings of pocket ultrasonography is useful because changes in image findings cannot be perceived in all subjects. Furthermore, even if changes in image findings are perceived, this evaluation is more subjective than examination of the thickness of the mammary glands, which can be expressed in objective numerical values. Therefore, it cannot be said that the same evaluation can be performed by all observers. When using pocket ultrasonography, mammary gland development is evaluated according to changes in the thickness of the mammary gland associated with the progress of pregnancy, and we think that it is valid to use these image findings as a reference when evaluating mammary development.

### 3. Limitations of This Study and Future Suggestions

The small number of subjects in this study limits the generalization of the results. In future, the relationship between the changes in mammary gland thickness and lactation will need to be explored in a larger study population. This may lead to the development of predictive indicators for lactation using pocket ultrasonography.

## Conclusions

Mammary gland thickness increased over the course of pregnancy in all subjects. The mammary gland thickness was significantly increased in the second of pregnancy and in the third pregnancy compared to the first pregnancy. We concluded that pocket ultrasonography is useful for the evaluation of mammary gland development over the course of pregnancy by the progress of mammary gland thickness.

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# 妊娠経過に伴う乳腺の発育評価における携帯型超音波画像診断装置の有用性

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## 要　　旨

**【目的】**本研究は、乳腺の妊娠経過に伴う発育評価における携帯型超音波画像診断装置の有用性を検討することを目的とする。
**【方法】**正常な経過をたどる妊婦 8 名を対象とした。携帯型超音波画像診断装置は、Vscan Dual Probe（GE ヘルスケア・ジャパン）を使用し、撮影部位は、右乳房 C 領域の 10 時 30 分の位置とした。対象は仰臥位とし、乳房が自然な形となるようタオルを用いて調整し、プローブは、プローブの辺縁と乳頭の辺縁が一致する位置に当てた。妊娠初期、妊娠中期、妊娠後期の計 3 回縦断的に撮影し、乳腺の厚さと画像所見を観察した。
**【結果】**すべての対象者において妊娠経過に伴い乳腺の厚さが増した。妊娠初期に比べて妊娠中期および妊娠後期は有意に乳腺の厚みが増していた（$p<0.01$）。また、対象者 8 名中 5 名（62.5%）において、妊娠初期から妊娠中期にかけて「乳腺が低エコー像となる」、「脂肪組織が薄くなる」という画像所見の変化が観察できた。画像所見は一様ではなく個人差が大きかった。
**【考察】**携帯型超音波画像診断装置は、乳腺の厚さの推移から乳腺の発育を評価することにおいて有用であることが示唆された。画像所見による発育の評価は難しく、乳腺が低エコー像となる」、「脂肪組織が薄くなる」といった画像所見の変化は評価の参考に用いることが望ましい。